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PREMATURE MORTALITY IN THE UNITED STATES

Public Health Issues in the Use of Years of Potential Life Lost

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Premature Mortality in the United States: Public Health Issues in the Use of Years of Potential Life Lost

INTRODUCTION

Mortality statistics are frequently used to quantitate the extent of public health problems and to determine the relative importance of the various causes of death. Analyses of crude and age-adjusted death rates have traditionally played an important role in this process; they enable priorities to be set and progress towards the achievement of public health goals to be monitored. Although these rates are important measures of the nation's health status, they often fail to tell the entire story of temporal changes in mortality. Since most deaths occur among persons in older age groups, crude and age-adjusted mortality data are dominated by the underlying disease processes of the elderly.

Alternative measures have been proposed to reflect the mortality trends of younger age groups. These measures provide a more accurate picture of premature mortality by weighting deaths occurring at younger ages more heavily than those occurring in older populations. One of these measures is the years of potential life lost (YPLL).

HISTORICAL PERSPECTIVES ON PREMATURE MORTALITY

In 1947, as a supplement to crude mortality figures, Dempsey introduced a method of quantifying premature mortality to measure the changing mortality consequences of tuberculosis (1). She tabulated the "potential years of life lost" by subtracting the age at death from the life expectancy at birth for persons who died during 1942 from heart disease, cancer, and tuberculosis. Greville subsequently altered this calculation, weighting each death by the life expectancy remaining at death (2). He also introduced the use of life tables calculated on the assumption that the given disease had been eliminated as a cause of death for all older age groups. This adjustment (the "zero-mortality assumption") only slightly changed the overall distribution of years of life lost and did not affect the rank order of causes (3).

Haenszel proposed directly age adjusting death rates to a standard population and then computing years of life lost from the resulting standardized deaths (4). Studies comparing temporal trends of premature mortality in populations widely separated in time have used a similar approach (5,6). In addition, standardized rates of "potentially productive years of life lost" have been developed to adjust for different age structures among populations and to describe race- and sex-specific patterns of premature mortality (7).

The use of premature mortality measures has recently become somewhat more common as a mechanism for establishing public health priorities (7-10). For this reason, the CDC introduced Table V of the *MMWR* in 1982. This table appears monthly and ranks the leading causes of premature mortality (11).

METHODOLOGIC ALTERNATIVES IN YPLL CALCULATION

Although many authors have emphasized the importance of the concept of premature mortality, there is no consensus on a functional definition or the best means of deriving a quantitative measure. Such a measure is necessary to monitor yearly trends in the pattern of premature mortality as well as to compare the relative importance of specified causes of death. This report will focus on YPLL, the measure of premature mortality used at CDC for the preparation of Table V of the *MMWR*. This section documents the current method of calculating YPLL used at CDC and discusses several adaptations of this measure for use in different situations.

Present Method of Calculation

For routine publication of Table V, YPLL is defined as the number of years of potential life lost by each death occurring before a predetermined end point, set at age 65 years. CDC calculates YPLL over the age range from birth to 65 years using age-specific death rates for 15 selected causes and supplementary data on causes of infant mortality, provided yearly by the National Center for Health Statistics (NCHS) (12). For timeliness, these data are estimated from a 10% sample of all death certificates filed during the year. Causes of death are grouped by an algorithm devised by NCHS to reflect the underlying cause of death as reported on the death certificate and the pathophysiologic process or organ system involved (i.e., malignant neoplasms or diseases of the heart).

The cause- and age-specific death rate is multiplied by the estimated population in that age range (provided by the Bureau of the Census) to determine the number and age distribution of deaths attributable to a specific cause (13). The number of deaths for each age is then multiplied by the years of life lost (the difference between the designated 65-year end point and the midpoint of the age range) to give an age-specific YPLL. For example, in the population 15-24 years old, the midpoint is 20 years and the YPLL is 45 years. Finally, the age-specific YPLLs are summed to give a total YPLL for each cause. The resulting distribution of YPLL, by cause, appears monthly as Table V (Table 1).

TABLE 1. Estimated years of potential life lost (YPLL) before age 65 and mortality, by cause of death, United States, 1984

Cause of mortality (Ninth Revision ICD)	YPLL (in thousands) for persons dying in 1984	Cause-specific mortality (rate/100,000)
ALL CAUSES (Total)	11,761	866.7
Unintentional injuries (E800-E949)	2,308	40.1
Malignant neoplasms (140-208)	1,803	191.6
Diseases of the heart (390-398, 402, 404-429)	1,563	324.4
Suicide and homicide (E950-E978)	1,247	20.6
Congenital anomalies (740-759)	684	5.6
Prematurity (765, 769)	470	3.0
Sudden infant death syndrome (798)	314	2.0
Cerebrovascular diseases (430-438)	266	65.6
Chronic liver diseases and cirrhosis (571)	233	11.3
Pneumonia and influenza (480-487)	163	25.0
Chronic obstructive pulmonary diseases (490-496)	123	29.8
Diabetes mellitus (250)	119	15.6

A persistent controversy in the calculation of YPLL concerns the definition of an upper end point. The CDC method of calculation does not count deaths of persons 65 years or older and assumes only 5 years of life lost for deaths of persons aged 55-64 years. In 1984, however, the remaining life expectancy for a 60-year-old person was 20.4 years (12). Thus, deaths in older age groups are underrepresented by the upper age limit of 65 years. However, this method preserves the emphasis on causes of mortality among younger persons.

Life-Expectancy Method

An alternative form of YPLL can be calculated that emphasizes the total life expectancy remaining at the time of death (Table 2). Age-specific death rates and population estimates are obtained from the same sources, but would not be truncated at age 65 (12,13). The number of deaths is estimated as above, but the YPLL for each death is calculated by taking the difference between the midpoint of the age range and the remaining life expectancy at that age from an abridged life table published yearly by NCHS (12). This table assumes that the risk of death in future years is approximated by the age-specific death rates for all causes in effect for the past year. For example, in the 75- to 84-year age group, the remaining life expectancy at the midpoint (80 years) was 8.2 years in 1984.

TABLE 2. Estimated years of potential life lost (YPLL)* and mortality, by cause of death, United States, 1984

Cause of mortality (Ninth Revision ICD)	YPLL (in thousands) for persons dying in 1984	Cause-specific mortality (rate/100,000)
ALL CAUSES (Total)	33,581	866.7
Diseases of the heart (390-398, 402, 404-429)	9,400	324.4
Malignant neoplasms (140-208)	7,171	191.6
Unintentional injuries (E800-E949)	3,381	40.1
Suicide and homicide (E950-E978)	1,833	20.6
Cerebrovascular diseases (740-759)	1,735	65.6
Chronic obstructive pulmonary diseases (490-496)	903	29.8
Congenital anomalies (740-759)	820	5.6
Pneumonia and influenza (480-487)	691	25.4
Chronic liver diseases and cirrhosis (571)	585	11.3
Prematurity (765, 769)	548	3.0
Diabetes mellitus (250)	525	15.6
Sudden infant death syndrome (798)	361	2.0

*Calculated by the remaining-life-expectancy method.

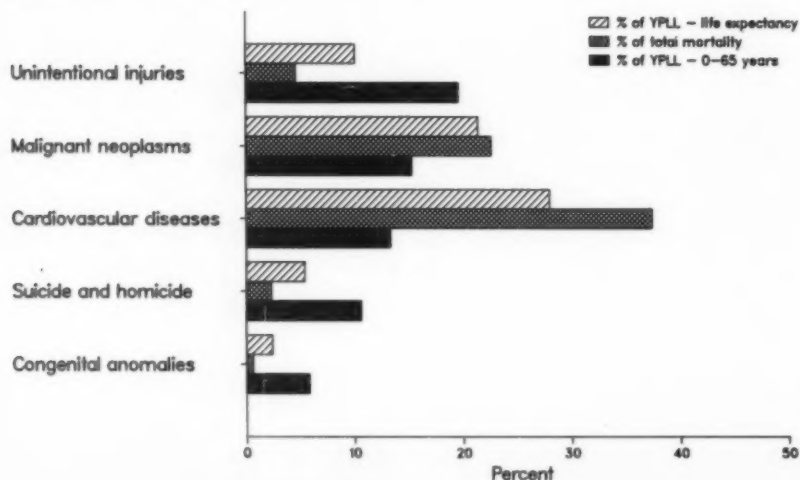
The number of deaths in each age group, grouped by underlying cause of death, is then multiplied by the remaining life expectancy at the midpoint of each age range, and the resulting numbers for all age groups are summed to obtain the total YPLL for this cause. Not surprisingly, this substantially changes both the total YPLL and the relative rankings for each cause (Table 3). When derived by the remaining-life-expectancy method, the proportion of YPLL attributable to each individual cause more closely resembles the pattern of cause-specific mortality than that of YPLL before age 65 (Figure 1).

TABLE 3. Rankings of the 10 leading causes of mortality and years of potential life lost (YPLL), by method of calculation, United States, 1984

Ranking	Crude mortality	YPLL—0-65 years	YPLL—life expectancy
1	Heart disease	Unintentional injuries	Heart disease
2	Malignant neoplasms	Malignant neoplasms	Malignant neoplasms
3	Cerebrovascular disease	Heart disease	Unintentional injuries
4	Unintentional injuries	Suicide and homicide	Suicide and homicide
5	COPD*	Congenital anomalies	Cerebrovascular disease
6	Pneumonia/influenza	Prematurity	COPD*
7	Suicide and homicide	Sudden infant death syndrome	Congenital anomalies
8	Diabetes	Cerebrovascular disease	Pneumonia/influenza
9	Cirrhosis	Cirrhosis	Cirrhosis
10	Congenital anomalies	Pneumonia/influenza	Diabetes

*Chronic obstructive pulmonary disease and allied conditions.

FIGURE 1. Percentage of years of potential life lost (YPLL)* and total mortality, by cause of death, United States, 1984



*Calculated by MMWR method (0-65 years) and by remaining-life-expectancy method

Mortality Groups

Another issue in the calculation of YPLL concerns the grouping of underlying causes of death as provided by NCHS. As a measure of mortality, YPLL underestimates the importance of diseases that contribute to, but are not recorded as, the underlying cause of death. A complete listing of any condition contributing to death is available from the NCHS tape "Mortality—Multiple Causes of Death," on which each condition recorded on the death certificate as either a contributing or an underlying cause of death is coded according to the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9 CM).

In addition, it is impossible at present to calculate YPLL on a timely basis for those diseases or disease categories that are not reported separately by NCHS, such as a composite category of YPLL attributable to all infectious diseases. Age-specific death rates are supplied annually by NCHS for only the 15 leading causes of mortality and certain causes of infant mortality. For example, no summary data on mortality due to infectious diseases would be available in the annual report other than the categories of pneumonia and influenza or septicemia (12). However, the tape "Mortality—Underlying Cause of Death" contains detailed listings of all deaths, with the coded underlying cause of death. This tape is available from NCHS, but only after a lag time of several years after publication of data from the 10% sample. Therefore, although these data allow for a more individualized design of mortality groups by ICD-9 CM codes, they are not useful when timeliness is important.

Age Limits

Some research may benefit from alterations in the YPLL age limits, either to emphasize the effects of a condition in a population at increased risk of illness or to study a particular subpopulation of interest. For example, a recent review of the premature mortality consequences of the acquired immunodeficiency syndrome (AIDS) was limited to persons aged 25-44, the ages with the highest incidence of illness (14). The most common use of this approach in the literature is to study the working years of life lost, calculated over the age range from age 15 or 20 to 65 years (3,4,6,7).

YPLL Rates and Age Adjustment

When yearly trends in YPLL are compared for dynamic populations or for substantially different populations, it may be helpful to calculate YPLL rates per 1,000 persons in the age range. Use of the YPLL rate adjusts the total and cause-specific YPLL for differences in total population. For example, although the total YPLL increased 0.4% from 1983 to 1984, the rate of YPLL per 1,000 persons decreased by 0.4% (15). Similarly, if two population groups have different age structures, it is preferable to compare standardized or age-adjusted YPLL rates. This rate is derived by multiplying the age-specific death rates by a reference population, either directly adjusting one group to the other or adjusting both groups to an external standard. As an example, when one compares rates of YPLL for whites with those for American Indians and Alaskan Natives, it may be more accurate to adjust the rates for age because of the marked difference in the age structure of the comparison groups (16).

TRENDS IN YPLL AND YPLL RATES, 1979-1984

Premature mortality in the United States, as measured by YPLL, decreased in the 6-year period 1979-1984 (Figure 2). The total years of potential life lost before age 65 from all causes decreased from 13.1 million YPLL in 1979 to 11.8 million in 1984, a difference of 10.4%. Over 40% of this change in the total YPLL is due to a decrease in premature mortality attributable to unintentional injuries.

YPLL due to 10 of the 12 leading causes decreased during this time frame (Table 4). The largest proportionate decreases were for chronic liver disease and cirrhosis (down 22.3%), unintentional injuries (down 19.2%), and pneumonia and influenza (down 14.7%). In addition, a 13.1% decrease occurred in infant deaths associated with premature birth, that is, deaths coded with the ICD-9 rubric 765 or 769—respiratory distress syndrome and disorders associated with short gestation and unspecified low birth weight. Only YPLL from chronic obstructive pulmonary disease and allied conditions (up 20.6%) and diabetes mellitus (up 7.2%) increased.

FIGURE 2. Years of potential life lost (YPLL) before age 65, from all causes, United States, 1979-1984

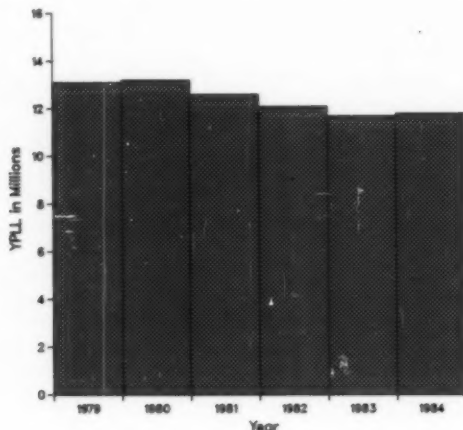


TABLE 4. Years of potential life lost (YPLL) before age 65 and percent change, selected causes, United States, 1979 and 1984

Cause of Mortality	YPLL (in thousands)		Percent change 1979-1984
	1979	1984	
ALL CAUSES	13,123	11,761	-10.4
Unintentional injuries	2,858	2,308	-19.2
Heart disease	1,678	1,563	-6.9
Malignant neoplasms	1,829	1,803	-1.4
Suicide and homicide	1,357	1,247	-8.1
Prematurity	541	470	-13.1
Congenital malformations	749	684	-8.7
Sudden infant death syndrome	320	314	-1.9
Cerebrovascular disease	290	266	-8.3
Chronic liver disease	300	233	-22.3
Pneumonia and influenza	191	163	-14.7
Diabetes mellitus	111	119	+7.2
Chronic obstructive pulmonary disease	102	123	+20.6

The rate of YPLL per 1,000 persons less than 65 years of age for all causes of death decreased by 12.8% from 1979 to 1984. The population in the age range increased 5.5 million persons, augmenting the decrease in the total YPLL. YPLL rates also decreased for these same 10 leading causes of premature mortality (Figure 3).

VARIATIONS IN THE PATTERN OF YPLL

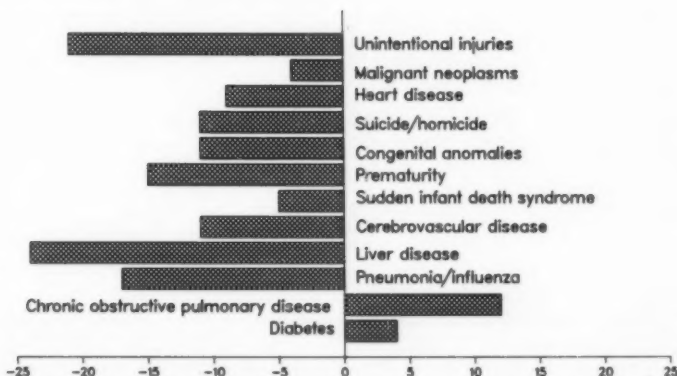
In addition to the programmatic implications of year-to-year changes in the total and cause-specific rates of YPLL, there may be marked differences in the rankings of the causes of YPLL among population subgroups. These differences can indicate populations with an increased risk of premature mortality (e.g., males compared with females) or identify individual causes of mortality of particular importance in certain of these groups, such as homicide among young black males. Interventions designed to alter this risk could then be targeted towards groups at highest risk, thereby increasing the effectiveness of those interventions. In this section, we examine differences in YPLL by race and sex and discuss its potential uses at the state and local levels.

Racial Variations in YPLL

Rates of premature mortality differ considerably among racial groups in the United States. During 1982, blacks had a YPLL rate from all causes of 99.2/1,000 population, a rate nearly twice that of whites (53.6/1,000 population). (Persons of other races are excluded from this consideration because they constitute a smaller and much more heterogeneous group that is not directly comparable to the other populations.) Clearly, blacks as a group are at increased risk of premature death when compared with whites.

In accordance with the racial disparity in rates of premature mortality from all causes, blacks have higher YPLL rates than whites for all of the causes of mortality presented in Table V of the *MMWR*, with ratios ranging from 1.1 to 3.6 times the rates of the white population

FIGURE 3. Percent change in rates of years of potential life lost (YPLL)* before age 65, selected causes, United States, 1979-1984



*YPLL per 1,000 persons less than 65 years of age

(Table 5). The largest ratios, those causes for which blacks have the highest excess premature mortality, are sudden infant death syndrome, prematurity, and pneumonia and influenza.

Differences in the relative ranks of the leading causes of premature mortality can also be noted between races. For example, suicide/homicide was the leading cause of premature mortality for blacks in 1982 (13.6 YPLL/1,000 persons), but the fourth leading cause for whites (5.4/1,000 persons). The rates for unintentional injuries and malignant neoplasms, however, are more comparable (ranking first and second, respectively, for whites, and second and fourth for blacks).

Variations in YPLL by Sex

The rate of YPLL from all causes varies considerably for males and females. Males had a rate of 76.6 YPLL/1,000 population in 1982, nearly twice the rate for females (41.6/1,000 population). In addition, men had higher rates than women for all of the 12 leading causes of premature mortality, with YPLL rate ratios ranging from 1.1 to 3.5 (Table 6). The largest excess in male premature mortality is in intentional (suicide and homicide) and unintentional injuries, with ratios of 3.5 and 3.1, respectively. In contrast, the rates for malignant neoplasms and cerebrovascular diseases have male-to-female ratios of 1.1.

Similar to the differences in racial groups, the ranking of sex-specific YPLL rates by cause varies markedly by sex. As an illustration, although the rates for malignant neoplasms are similar for both sexes (9.2 YPLL/1,000 population for men and 8.5/1,000 for women), malignant neoplasms are the leading cause of premature mortality for women but only the fourth leading cause for men. This difference reflects the excess risk of premature mortality for men due to heart disease and unintentional and violent injuries.

Race- and Sex-Specific YPLL Rates

To define public health priorities further, race- and sex-specific YPLL rates can be determined. Black males had the highest rate of YPLL from all causes in 1982, followed by black women and white men; white women had the lowest rate (Figure 4). Black males had 3.5 times the risk of premature mortality of white women, while black women and white men had

TABLE 5. Rates of years of potential life lost (YPLL)* and YPLL rate ratios, by race, selected causes, United States, 1982

Cause of Mortality	Rates of YPLL		YPLL rate ratio (black/white)
	Blacks	Whites	
Suicide and homicide	13.6	5.4	2.5
Unintentional injuries	12.7	11.6	1.1
Heart disease	11.7	6.5	1.8
Malignant neoplasms	10.4	8.8	1.2
Prematurity	6.2	1.9	3.3
Congenital malformations	4.8	3.4	1.4
Sudden infant death syndrome	3.7	1.3	2.8
Cerebrovascular disease	2.9	0.8	3.6
Chronic liver disease	2.3	1.1	2.1
Pneumonia and influenza	2.0	0.6	3.3
Diabetes mellitus	1.0	0.5	2.0
Chronic obstructive pulmonary disease	0.9	0.5	1.8

*YPLL before age 65 per 1,000 persons less than 65 years

a rate nearly twice that of white women. Black men have now been clearly identified as the group most at risk of premature death and, consequently, most in need of interventions to lower this risk.

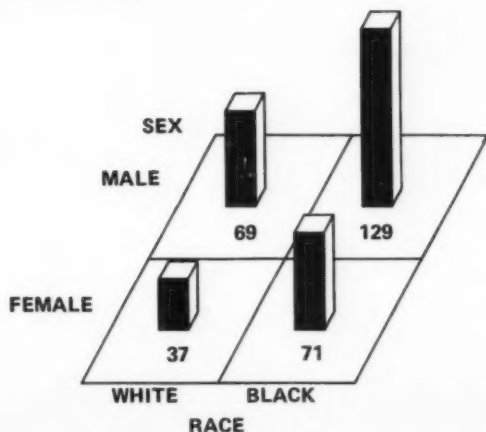
An even more striking difference can be noted in selected cause-specific YPLL rates (Table 7). Intentional injuries, particularly homicide, are identified as predominantly a condition affecting black males, with white males having the second highest rate. In contrast, the pattern for malignant neoplasms is more evenly distributed among all race/sex groups.

TABLE 6. Rates of years of potential life lost (YPLL)* and YPLL rate ratios, by sex, selected causes, United States, 1982

Causes of Mortality	Rates of YPLL		YPLL rate ratio (male/female)
	Males	Females	
Unintentional injuries	17.8	5.7	3.1
Suicide and homicide	10.1	2.9	3.5
Heart disease	9.7	4.4	2.2
Malignant neoplasms	9.2	8.5	1.1
Congenital malformations	3.8	3.3	1.2
Prematurity	2.8	2.0	1.4
Sudden infant death syndrome	2.0	1.3	1.5
Chronic liver disease	1.7	0.8	2.1
Cerebrovascular disease	1.3	1.2	1.1
Pneumonia and influenza	1.0	0.6	1.7
Chronic obstructive pulmonary disease	0.7	0.6	1.4
Diabetes mellitus	0.6	0.5	1.2

*YPLL before age 65 per 1,000 persons less than 65 years

FIGURE 4. Rates of years of potential life lost (YPLL)* before age 65, all causes, by race and sex, United States, 1982



*YPLL per 1,000 persons less than 65 years of age

PUBLIC HEALTH USES OF YPLL

YPLL is only one of a number of mortality measures that have broad public health applications. Yet this simple index of premature mortality can complement traditional methods of quantitating mortality, such as crude or age-adjusted death rates. The major strengths of YPLL are that it is simple to compute and comprehend and it effectively emphasizes deaths of younger persons, in contrast to usual mortality statistics, which are dominated by deaths of the elderly.

Geographic variations in premature mortality can also be a useful tool for health planning at the state or local level. A delineation of the pattern of YPLL rates among varied populations can provide an accurate description of the causes of premature mortality for those persons at highest risk of premature death. This type of analysis can be done on national data, such as presented in this document, or on local mortality data.

State-specific rates of YPLL can be used for planning and evaluating local public health interventions. Sex- and race-specific YPLL rates can, within the statistical limitations of population size, be used to target and monitor those populations at highest risk. Calculation of YPLL at the state level is presently being evaluated by CDC in cooperation with interested state health departments. For example, the importance of meningitis and unintentional injuries as causes of premature mortality in Alaska can be readily seen by the calculation of YPLL (CDC, unpublished data).

YPLL and YPLL rates can assist in the performance of three basic public health functions: the establishment of research and resource priorities, the surveillance of temporal trends in premature mortality, and the evaluation of the effectiveness of program interventions. Within certain limitations, YPLL can serve these functions at the national, state, or local level. Finally, quantifying YPLL for individual causes of mortality or for behavioral risk factors associated with a range of mortality consequences (e.g., tobacco or alcohol use) can provide a simple method to target health education efforts to sections of the general population most in need of public health interventions.

TABLE 7. Rates of years of potential life lost (YPLL*), by race and sex, selected causes, United States, 1982

Causes of Mortality	Rates of YPLL			
	Black males	Black females	White males	White females
Suicide and homicide	23.1	4.9	8.3	2.6
Unintentional injuries	19.4	6.5	7.7	5.5
Heart disease	15.0	8.5	9.1	3.8
Malignant neoplasms	11.6	9.4	9.0	8.5
Prematurity	7.3	5.1	2.2	1.6
Congenital malformations	5.1	4.5	3.6	3.1
Sudden infant death syndrome	4.4	3.1	1.7	1.0
Chronic liver disease	3.0	1.8	1.5	0.6
Cerebrovascular disease	3.1	2.7	1.1	1.0
Pneumonia and influenza	2.5	1.5	0.7	0.5
Chronic obstructive pulmonary disease	1.1	0.7	0.6	0.4
Diabetes mellitus	0.9	1.0	0.5	0.4

*YPLL before age 65 per 1,000 persons less than 65 years

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